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PORTABLE AIR-CONDITIONING UNIT, PARTICULARLY A PERSONAL AIR-CONDITIONING UNIT

The invention relates to a small format, portable air-conditioning unit, particularly to a personal air-conditioning unit.

Especially persons, who spent time in extreme surroundings with high or low temperatures, would require, for maintaining or extending their efficiency and working capacity as well as for promoting their general well being, at least temporarily cooling or heating during their work. As example, soldiers may be mentioned here, who are deployed in desert actions, in which the surrounding temperature is high. Divers, who must carry out their task at extremely low water temperatures, are another example. If, for example, a soldier could experience some cooling during his deployment or if a diver could become warmer, his performance would necessarily improve or, at least, be maintained for a longer period of time. People, who must act in formal clothing at high temperatures and would like to avoid perspiring excessively, are yet another example.

However, in other areas also, the possibility for heating or cooling would be desirable. Primarily the private area is to be mentioned here, for example, while hiking. Experience has shown that one perspires relatively heavily while hiking and that at least occasional cooling would be very pleasant. The situation is similar, for example, when visiting a stadium, where one sits at times for a relatively long period in the blazing sun. A further target group, which would value, the possibility of rapid cooling in situ, comprises sensitive, sick or older persons, who would have problems, for example, with circulation or breathing or the like at higher surrounding temperatures or also people who suffer from hot flashes and episodes of perspiring heavily.

With that, it is an object of the invention to indicate an air-conditioning unit, which can be used especially as a personal air-conditioning unit (which can, however, also be used for air-conditioning objects) and provides a remedy here.

To solve this problem pursuant to the invention, a small-format air-conditioning unit, which can be carried readily by one person and therefore weighs little, is provided, with a small-format housing with a housing section containing a latent heat storage unit, at which housing an inlet is provided for a gaseous or liquid medium, which is to be passed past the latent heat storage unit, exchanging heat there, and an outlet for emitting the cooled or heated medium, as well as with conveying means, which can be operated using an energy supply unit provided at the housing for conveying the medium for an autarc operation of the air-conditioning unit.

The small-format, portable air-conditioning unit is very light, appropriately varying in weight from 1.5 to 2.5 kg and can consequently be carried readily by one person. Depending on the design, a gaseous or liquid medium can be cooled or heated by passing it by a latent heat storage unit, this medium subsequently being used to cool or heat the person carrying the air-conditioning unit or an object, at which the air-conditioning unit is disposed. Conveying means, which can be operated electrically, are provided for conveying the medium. The portable air-conditioning unit can be operated using an integrated energy supply, so that an autarc operation of the equipment is possible. This means that the air-conditioning unit can be operated at any place without being connected to a power supply or the like. A cooling or warming medium is generated particularly advantageously using a latent heat storage unit, which contains a suitable phase-changing material and which must be "charged" appropriately before the air-conditioning unit is operated. Because of its phase-changing properties or its ability to store energy, this phase-changing material or heat-exchanging storage unit gives off the energy to the medium passed by. Simple heating or warming of the medium

in situ therefore takes place without the need for an external energy supply and the like, aside only from the conveying means.

Over all, the invention indicates a simply configured air-conditioning unit, which can be carried by any person and can be operated in an autarc manner in any situation and in any place and enables cooling or heating to be carried out in situ in a simple manner.

According to a first development of the invention, the medium may be a gas and the conveying means a fan. According to a particular advantageous development of the invention, air from the surroundings, which is aspirated over at least one aspirating opening, formed by the inlet described, is used as gas. The air from the surroundings is supplied to the latent heat storage system, where it is, for example, cooled and subsequently supplied to the person or the object for cooling. In this connection, it is sufficient to cool the air from the surroundings by approximately 5° to 10°C, in order to bring about a pleasant and sufficient cooling effect for a person. Stronger cooling frequently is not required, or as otherwise the danger exists of excessive local cooling.

According to a further development of the invention, the cooled or heated air from the surroundings is supplied to at least one exit nozzle at the outlet, leading to the surroundings. This means that an open system is realized here with an inlet open to the surroundings and an outlet open to the s urroundings. The cooled air from the surroundings is now supplied over the outlet nozzle, for example, to the person. The air-conditioning unit is worn, for example, at the belt of the person and positioned so that the outlet nozzle is below the outer clothing of the person, for example, of the soldier, so that the cooled air can be blown below the outer clothing. In order to achieve ventilation over the largest possible area, it is appropriate to provide a suitably shaped outlet section having several outlet nozzles at the outlet. The outlet section may appropriately be shaped essentially in the form of a plate or half a plate and consists of a deformable skin-

friendly material, which can therefore lie flat on the skin or on the underwear of the person, several outlet nozzles pointing in different directions. By these means, it is ensured that the outlet section is supported well, adapting itself. On the other hand, the differently directed outlet nozzles ensure ventilation, and, with that, distribution of the air over a larger area. The cooling effect is improved by these means.

Aside from a system, which is directly open at the inlet and at the outlet, it is also conceivable, according to an inventive development, to provide connecting means at the outlet means for coupling with a pipeline, which carries the gas further. This is appropriate, for example, if the inventive air-conditioning unit is used primarily in the private area. The air-conditioning unit may be constructed, for example, as a backpack device or carried in a backpack and the cooled air may be passed over a pipeline, which is underneath the outer clothing of the hiker, to any region of the body. Of course, a two-dimensional outlet section, having several, differently directed outlet nozzles, may also be provided here at the end of the pipeline, as already described for the embodiment named above.

Aside from the two quasi open embodiments described here, it is, however, also conceivable, when a gas is used as heat-conducting medium, to provide connecting means at the inlet and the outlet for coupling with a pipeline carrying the gas. A closed system is thus realized here. For this system, the pipeline may be integrated, for example, in a "cooling vest" or "cooling jacket" or "cooling pants" or "cooling suit". The pipeline inlet and the pipeline outlet have appropriate means, which can be coupled with the corresponding connecting means at the air-conditioning unit. This means that cooled gas, which can of course also be air present in the air-conditioning unit or the pipeline system here, is circulated within this pipeline system, including the air-conditioning unit with continuous cooling. In every case, the connecting means may be simple plug-in connections, which make a tight connection possible.

Aside from using a gaseous medium, the possibility, of course, also exists of using a liquid as medium, in which case the conveying means is a pump. Only a closed system is possible here. This means that appropriate connecting means for coupling with a pipeline carrying the liquid are provided at the inlet and at the outlet. As already described, the pipeline advisably may be integrated in an item of clothing, which is worn under the outer clothing, so that the liquid can be passed as close as possible to the perspiring or freezing regions of the body of the wearer.

In order to avoid losses as far as possible, it is advisable to insulate the housing at least in the region, in which the latent heat storage unit is provided. Preferably, however, the whole of the housing is insulated. It is conceivable here to construct the housing itself using an insulating material. However, it is also possible to provide appropriate insulating coverings or inserts or fillings or the like.

According to an advantageous further development of the inventive concept, a preferably electrically adjustable flap-like control element may be provided at a position downstream from the latent heat storage unit. By means of this control element, the degree to which a first medium path, which passes the medium past the latent heat storage unit, and a second medium path, over which the medium is not passed past the latent heat storage unit, are open, can be varied. Both medium paths carry conveying means. By appropriately positioning the control element, the "mixing ratio" of the medium, passed over the two medium paths, can be varied and by these means, especially in the case of an open system, for which air from the surroundings is aspirated, the temperature can be controlled in a simple manner. For example, if a person feels that the cooling is excessive, the second medium path can be opened somewhat, so that the aspirated, relatively hot air from the surroundings can be admixed with the air cooled at the latent heat storage unit to an extent depending on the degree of opening and the cooled air can be heated somewhat once again. The adjustment advisably is made manually or electrically, driven over the integrated energy supplies.

The fact that the latent heat storage unit can store only a certain amount of energy is a central problem. Once it has delivered this, it is, as it were, "consumed". It now becomes necessary to "charge" the latent heat storage unit once again so that the air-conditioning unit can be used once more. Different possibilities are conceivable for this purpose. According to a first development of the invention, at least one electrically operated cooling and/or heating device may be provided in the housing at a place close to the latent heat storage unit. This means that the cooling or heating of the latent heat storage unit takes place inside the device. Provided that it is sufficiently powerful, the integrated energy supply system can be used to supply the cooling or heating unit. However, it is also conceivable to provide means, by which the air-conditioning unit can be connected to an external supply of energy, in order to operate the cooling or heating device. The air-conditioning unit may also be connected, for example, to a conventional supply network for "charging". An ordinary car battery is also conceivable, if the air-conditioning unit is operated for personal use outside of the house.

According to a particularly appropriate development of the invention, at least one Peltier element, which cools or heats depending on the direction of the current passed over the element, is provided as a cooling or heating device. This at least one Peltier element appropriately is integrated into the housing wall, which separates the first and second medium paths, so that, with one side, it is immediately adjacent to the latent heat storage unit and, with the other, lies in the second medium path. When there is cooling over the Peltier element, the heat, which develops on one side that is directed to the second medium path, must be dissipated. For this purpose, the already mentioned control element is activated in order to open the second medium path somewhat, so that air can be aspirated over the latter and the heat dissipated. In any case, the latent heat storage unit can easily be cooled in this way and, with that, "charged". The corresponding also applies for heating. Instead of a Peltier element, a heating coil may also be used, however, only for heating.

Aside from using an integrated cooling or heating device, it is also conceivable to provide an external station with a cooling or heating device for cooling or heating the latent heat storage unit and to dispose it at or in the portable air-conditioning unit. It is, for example, conceivable that an appropriate receptacle, into which the device is to be inserted, is provided in such a station. Subsequently, the station is switched on and the cooling or heating takes place. Appropriate Peltier elements for cooling or heating or one or more heating coils for heating the latent heat storage unit can also be provided here.

Of course, instead of the integrated devices or the station named, it is also possible to use conventional cooling or heating devices, such as a refrigerator or freezer, an oven, a microwave over like, in which the device is placed for "charging".

According to a further, appropriate configuration of the invention, the latent heat storage unit itself can be removed from the housing. The latent heat storage unit can then be cooled or heated separately and, after being "charged", be inserted once again.

For controlling the cooling, the amount of medium flowing through advisably can be varied. For this purpose, at least one temperature sensor or one sensor for detecting the amount flowing through, as well as suitable evaluating electronics are provided, over which the conveying means can be controlled. Furthermore, a display indicating the extent to which the integrated energy supply is charged, may be provided, so that the wearer always knows whether and optionally also how long the air-conditioning units can still be operated.

A display, indicating the extent to which the latent heat storage unit is charged, is also conceivable and may be implemented by direct measurement with suitable sensors or by a calculation program.

Accumulators or batteries may be used for supplying energy and the use of fuel cells is also appropriate. Furthermore, solar cells can also be used, particularly where the air-conditioning unit is used during continuous sunshine. Of course, it is also conceivable, for example, to combine accumulators and solar cells, the solar cells then attending to the continuous charging of the accumulators. It is also possible to operate the system in such a manner, that the solar cells primarily supply the energy, whereas the accumulators have a supportive function when insufficient energy is supplied by the solar cells.

Furthermore, at least one cooling or heating compartment may be provided for unrelated objects. The temperature of the compartment may be controlled by a further cooling or heating device, especially by at least one Peltier element, which can be operated over the integrated energy supply and is assigned to the cooling or heating compartment. For example, the temperature of important medicinal drugs or the like could be controlled by placing them in the compartment which, in view of the relatively small dimensions of the air-conditioning unit, should not be too large.

Any phase-changing material, which is known and can be used for the respective area of application, can be employed for storing latent heat. Most easily, water is used for this purpose. However, paraffin or wax can also be used. Furthermore, salt hydrates, for example, can be used particularly because of their high heat of melting, etc.. In order to avoid that the medium freezes and the medium path or paths become blocked, for example, when the medium is cooled with ice, a liquid medium must have a freezing point or sublimation point, which is clearly below the freezing point of the material storing the latent heat or clearly above the sublimation point. For example, if ice is used as material, which stores the latent heat, appropriate cooling brine should be used as a liquid medium.

For reasons of insulation as well as to prevent the penetration of dirt into the housing, it is appropriate if the or every opening in the housing can be closed off. This should be so particularly also when appropriate connecting means are provided at the inlet or outlet, in order to prevent that these become contaminated or damaged, so that a connection conceivably no longer is possible. The openings can be opened or closed jointly over a single actuating means, such as a lever. The caps or flaps are thus coupled with the common lever. Moreover, the inlet and outlet, for example, can be opened together, when the lever is brought into a first position. Upon movement into a second position, the flap-like control element assigned to the second medium path, if present, is actuated.

Aside from the inventive air-conditioning unit, the invention furthermore relates to an air-conditioning system, comprising an air-conditioning unit of the type described above, as well as to a piece of clothing, which is to be worn on the body of a person and has at least one integrated pipeline for conducting the cooling or heating medium, connecting means, for coupling with appropriate connecting means at the inlet and/or at the outlet of the pipeline of the piece of clothing, being provided at the inlet and/or at the outlet of the air-conditioning unit.

Furthermore, the invention relates to a method for cooling a person using an air-conditioning unit of the type described above, which aspirates and cools air aspirated from the surroundings and delivers it over at least one outlet nozzle and is placed on the person in such a manner, that the air delivered is blown under the outer clothing onto the underwear or the skin of the person, so that, aside from the cooling effect by the cooled air, an additional cooling effect is achieved by utilizing the heat of evaporation abstracted as the natural moisture of the underwear or of the skin is dried by the aeration. The overall cooling effect can be improved even further by utilizing the heat of evaporation abstracted by the targeted blowing of cooled air. It is particularly appropriate here if the cooled air is blown in different directions over the largest area

possible, in order to cover as much as possible of the underwear, which is usually moistened by perspiration, or of the moist skin.

Further advantages, distinguishing features and details of the invention arise out of the example described below, as well as out of the drawings, in which

Figure 1 shows a sectional view through a diagrammatic sketch of an inventive air-conditioning unit,

Figure 2 shows a plan view of the unit of Figure 1,

Figure 3 shows a sketch for representing the arrangement of an air-conditioning unit on a person,

Figure 4 shows a sectional view of the diagrammatic sketch through the person, shown in Figure 3, in the region of the arrangement of the air-conditioning unit and

Figure 5 shows an inventive air-conditioning system.

Figure 1 shows an inventive air-conditioning unit 1 with a housing 2 consisting, as a whole, preferably of an insulating material. A housing section 3 for accommodating a latent heat storage unit 4 is provided in the housing 2. The latent heat storage unit 4 comprises a storage housing 5, in which the actual latent heat storage material, that is, the phase change material, is disposed. Water/ice may be used, for example, as latent heat storage material. With respect to its size or the material selected (optionally a flexible material), the storage housing should be designed so that, when ice is used as the latent heat storage material, the changes in volume associated with freezing

and melting are taken into consideration or compensated for, so that bursting during freezing is not possible.

The latent heat storage unit 4 is disposed in such a manner in the housing section 3, that medium paths 6 for a gaseous medium, which is air from the surroundings in the example shown and supplied by way of the inlet 7, here in the form of an aspiration opening, remain above and below and especially also at the sides. The aspirated air flows along these medium paths 6 past the latent heat storage unit. Since the temperature of this area is clearly higher than that of the latent heat storage unit, there is an exchange of heat as the air flows by, that is, the air passing by is cooled.

In order to aspirate and pass the air into or through the housing, provision is made for conveying means 8 in the form of a fan, which is operated over an integrated energy supply 9. The aspirated and conveyed air is supplied to the outlet 10, where an outlet section 11 is provided, at which several outlet nozzles 12, directed in different directions, are provided. By these means, the cooled air is delivered back to the surroundings. The outlet section 11 (see Figure 2) is flat and plate-shaped or has any convenient shape and consists of a relatively soft, clinging and optionally skin-friendly material, so that it clings to the surface, with which it is in contact. However, the material must be sufficiently stable so that the outlet openings are not pressed shut.

As described, an integrated energy supply 9 is provided. This may be, for example, in the form of a battery or an accumulator. It is, however, also conceivable to use solar cells 13 as an or as an additional energy supply 9. These solar cells 9 then either act independently as energy supply or are charged by way of the accumulator.

Furthermore, a suitable electronic system 14 is provided, which is disposed in a suitable section 15 of the housing together with the energy supply. The electronic system, for example, detects and regulates the amount flowing through by

appropriately triggering the conveying means 8. For this purpose, a flow sensor, the details of which are not shown, and optionally a temperature sensor for detecting the temperature of the cooled air are provided.

The operation is such that, for the desired cooling, initially, a flap 16, which closes off the inlet 7, is opened, so that the inlet 7 or the aspiration opening is opened. A filter or the like, over which the aspirated air from the surroundings is filtered, may, of course, be inserted in the inlet 7. When the fan is running, the air is aspirated, flows along the medium paths 6, is cooled and conducted to the outlet 10 and discharged over the outlet nozzles 12. The medium paths 6 should be sufficiently wide, so that an obstruction by icing of moist air, frozen in the latent heat storage unit, is avoided.

Furthermore, a control elements 17 is provided, which can be adjusted by way of the electronic system 14 and the energy supply 9 and is in the form of a flap, by means of which the opening cross-section of the medium path 6 can be varied. The control element can be moved between an open position (shown in Figure 1 by solid lines) and a closed position (shown in Figure 1 by a line of dots and dashes); in other words, it can open or close the cross section completely. If the control elements 17 is opened a little, a second medium path 18, which leads directly to the fan, opens up. When the fan is running, air is also pulled over this medium path 18. Since this air does not come into contact with the latent heat storage unit, it is not cooled, so that it is distinctly warmer. Overall, cooled air is mixed at the fan with the warm, aspirated air so that the temperature of the air, finally discharged, can be varied by these means.

Even though the latent heat storage unit 4 can be removed from the housing in order to be charged, for example, in a conventional, commercial freezer or freezer compartment, where the liquefied water is frozen once again, such a possibility is not always available. For this purpose, a cooling and heating device 19 in the form of several Peltier elements is disposed in a housing wal l 20, which separates the first medium path 6 from the second medium path 18. This Peltier element is operated by

way of the integrated energy supply 9 and is intended to cool the latent heat storage unit and freeze the liquefied water once again. If such an (exclusive) operation over the integrated energy supply 9 is not possible, connecting means 21, which are indicated by broken lines, are provided, over which coupling to an external energy supply, such as a vehicle battery or the like, is possible.

If current is supplied over a Peltier element, one side of the element heats up and the opposite side cools down. In the example shown, the operation is such that the side of the Peltier cooling device, pointing to the latent heat storage unit, is cooled, whereas the opposite side warms up. Since both sides communicate with the respective medium paths 6, 18, heat transfer can take place directly there. During the operation of this Peltier cooling device, it is necessary to dissipate the heat formed at the side warming up. This is accomplished owing to the fact that the control elements 17 is closed, that is, that the housing section, in which the latent heat storage unit is located, is closed. Air is now aspirated by the fan exclusively over the second medium path, which dissipates the heat emitted at the Peltier cooling element 19.

Instead of a Peltier cooling device, which is operated in the reverse manner when a different latent heat storage unit, such as a paraffin storage unit, is used, by means of which the air from the surroundings can be heated and which is heated by the Peltier cooling device, it is also possible to use, for example, a heating coil or the like, which heats the latent heat storage unit.

Furthermore, a cooling or heating compartment 22, in which an unrelated object can be cooled or heated, is shown in Figure 1. For controlling the temperature of the compartment, a further cooling or heating device 23, consisting especially of one or more Peltier elements, is provided, which can cool or heat depending on the mode of operation of the interior of the compartment. It is operated by way of the integrated

energy supply, since the cooling of an unrelated object is required primarily when the user wears the air-conditioning unit.

Figure 2 shows a plan view of the air-conditioning unit 1 of Figure 1, in which, for the sake of greater clarity, the latent heat storage unit 4 as well as the fan 8 has been drawn using broken lines.

Figure 3 finally, by way of example, shows the use of an inventive air-conditioning unit in the form of a belt device. The air-conditioning unit 1 is disposed at a belt 24, which a person 25 is wearing. It is positioned in such a manner that the outlet section 11 (see Figure 4) is below the outer clothing 26 of the person. The outlet section 11 may, for example, be pushed through the opening of a buttoned jacket or the like or through an opening provided especially for this purpose. It may be positioned either above the underwear, so that the cooled air is blown in between the outerwear and the underwear. Furthermore, the outlet section 11 can be taken below the underwear in direct contact with the skin. The positioning is shown in a diagrammatic sketch in the form of a sectional view in Figure 4. Either the skin or the underwear is labeled 27. The air-conditioning unit can also be worn hidden under sack coats or articles of clothing.

Figure 5 shows an inventive air-conditioning system 28, comprising an air-conditioning unit 1', in which conveying means 8' are integrated in the form of a liquid pump instead of a fan. An ice storage unit can once again be used as latent heat storage unit 4'. Contrary to the embodiment of Figure 1, a liquid, such as a cooling brine, which is pumped by the liquid pump 8', is used as medium here. At the inlet 7' and at the outlet 10', connecting means 29, 30 are provided, to which corresponding connecting means 31, 32 can be connected, over which the air-conditioning unit 1 can be coupled with a pipeline 33. The pipeline 33 leads to a piece of clothing 34, where it is integrated in meandering fashion. The piece of clothing 34 thus is a cooling vest with integrated cooling pipelines, through which the cooled liquid can be circulated in a

closed system when the pump 8' is operating. The emerging liquid once again is supplied to the air-conditioning unit 1'.

Instead of a liquid cycle, a gaseous medium can also be used within the closed system.

In conclusion, it should be pointed out that the examples shown are not limiting. The objective is to keep the air-conditioning unit as small as possible, so that it can readily be taken along. Other housing configurations are also conceivable.